

The Measurement of C-5A Aircrew Performance

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ABSTRACT

This paper describes efforts to develop and validate a performance measurement system (PMS) for C-5A aircrews. To date, a PMS has been developed and successfully integrated with one of the C-5A flight simulators at Altus AFB, OK. The system is currently being used as a routine part of the simulator training curriculum and is undergoing evaluation. This paper describes the capabilities of the simulator PMS and presents the results of the preliminary data gathered during the validation phase of the project.

Introduction

In the late 70's, the need for improved measurement capabilities in the operational training environment was realized and a major R&D program was initiated. In order to document the effectiveness and efficiency of the simulator training syllabus, it seemed desirable to quantitatively assess aircrew proficiency both in the simulator and the aircraft. The development of objective performance assessment capabilities for operational flight training systems was viewed as a two-phased process. The first phase would focus on the implementation of a measurement system within the flight simulation environment, while the second would focus on the aircraft. Two target applications were eventually selected: first, the development of a PMS for the C-5A transport aircraft, which is the focus of the present paper and second, the development of an air combat maneuvering PMS applicable to both the simulation environment and instrumented range facilities.

Description of C-5A PMS

A front-end analysis was initiated to define requirements for an objective PMS for members of the C-5A aircrew utilizing the existing C-5A simulator. Based upon the functional capabilities described in the final report (Swink et al, 1978), a contract was awarded for the development, fabrication, and integration of a measurement system for the C-5A flight simulator. The resulting system was installed on one of the simulators located at the C-5A Training Squadron at Altus AFB OK. Acceptance testing was completed in October 1982. Currently, the system is undergoing a two-year evaluation. Before describing the evaluation and some of the initial findings, a brief description of its functional capabilities is presented.

Mission Control. The C-5A PMS provides the potential for a precise definition of mission profiles whereby the proficiency of each aircrew member can be determined. The level of detail for the profile corresponds to that of a complete specification of student responses and aircraft/environmental factors (conditions, standards, etc.) to be addressed by the system. The

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capability is also provided for the creation of new mission scenarios by instructor personnel within Military Airlift Command (MAC). The C-5A PMS has the capability to operate in either a preprogrammed or manual mode. In the preprogrammed mode, the PMS does not allow any alteration of the predefined mission; only monitoring and feedback controls are available. The manual intervention mode, however, provides the instructors with the ability to completely control the PMS mission. Predefined malfunctions may be activated or cleared at any time and additional malfunctions not contained in the original PMS scenario may be inserted. Of course, the instructors may allow the PMS scenario to operate as initially designed by the course developers.

Performance Monitoring, Assessment, and Analysis. The C-5A PMS monitors most switch positions, control settings, and instrument readings from the flight deck. It provides a real-time evaluation of proficiency for all crew members individually, as well as the coordination among aircrew members. Proficiency evaluations can be accomplished using the preprogrammed mission profiles. It requires that mission essential/critical flight tasks be included within the preprogrammed profiles and that performance standards be precisely defined. The system provides a measurement capability for checklists, procedures, navigational profiles, and aircraft state parameters. It also has the capability to store, retrieve, and summarize all performance measures.

Performance Feedback and Displays. The PMS provides the following display and feedback capabilities: (a) mission sequence display--summary displays of the sequences of tasks; (b) route chart display--graphic background displays corresponding to departure, enroute, and approach plates; (c) checklist/procedure display--displays of predefined sequences of actions to be performed by crew members; (d) error alert display--message alerting instructor to crew errors as they occur in the predefined tasks; (e) proficiency assessment display--detailed alphanumeric displays relative to any specific predefined performance segment or task; (f) debriefing report--hard-copy containing objective performance data which the instructor may use for debriefing; and (g) help display--22 pages of on-line instruction on the use of the PMS.

To meet these functional capabilities, a "piggy-back" system configuration was required. In other words, the C-5A PMS is autonomous and independent of the host simulator in the sense of using its own processor and peripherals. All mission control, measurement computations, and display capabilities are accomplished with the PMS hardware. It is interfaced with the host simulator, so that it passively monitors all I/O signals (thereby obtaining all necessary data). It also has the capability to pass data actively to the host simulator for problem control and malfunction insertion, as necessary.

From this brief description, it should be apparent that the C-5 PMS provides a much wider range of capabilities than only performance assessment. It encompasses most functions which have been typically associated with the design of instructor/operator stations. As such, it can be considered a stand-alone instructional support system. Discussion now turns to the evaluation of the C-5A PMS and some of the initial findings.

Evaluations Plan for the C-5A PMS

The evaluation of the C-5A PMS will address the following areas: mission generation, operation, measurement, perceived operational utility, and

operational suitability.

Scenario Design Capabilities. The PMS scenario author has a number of difficult tasks. He must specify all relevant mission components in comprehensive detail. Flight checklists must be specified not only as to operation, but as to sequence. Navigational profile information must be included for the main flight path and any alternative flight paths among which the author might wish the students to choose. The PMS author is presently aided by several items. Different forms are provided to aid in constructing the various disk files that constitute a PMS scenario. A line text editor provides the author with the means of entering data from these forms into system and modifying it once it has been entered. The mission generation program provides a syntax and consistency check of the work. A consideration of this complex job leads to the following questions: Are the current aids adequate or do they need improvement? If they need improvement, how should they be improved? Are any additional aids needed? If so, what are they and how should they be integrated into the system?

System Operation. The PMS operation consists of two major types of operations: housekeeping and mission conduct. The housekeeping operations consist of the daily turn-on procedure, the confidence test, and the system shutdown. The mission conduct operations consist of commands to perform among other things the following: selection of PMS operating mode, performance monitoring, sign-on, real-time interaction with PMS monitoring, instructor station commands, and program termination. Of these two types of operations, it is the mission conduct operations that have the greatest impact upon the C-5A instructors. Another objective will be to assess these operations in order to identify the following: operations that are confusing or difficult to perform; operations that are unused or ineffective; operations that are not presently in the system that could prove helpful to instructors; suggestions for improving or replacing operations that are presently confusing or difficult to perform; and operations that instructors find helpful or effective.

Measurement Validation. At present, the PMS provides performance measures at five different levels. Level 1 measurement consists of assessment for individual tasks (e.g., lowering the landing gear before final approach). Each task is assigned a point value and tasks are scored according to a predefined algorithm. There are separate scores on each task for each crew member on each individual task. Scored tasks have been specified in advance by the scenario author along with the total possible point value for each task. The individual scores are then combined into three performance task groups for level 2 scores: checklist/procedures, monitorable parameters, and navigational profiles. Level 2 scores are computed by taking the total points earned under each group. If certain critical tasks are missed, the overall total is reduced by a predetermined criticality factor. Level 2 scores are obtained for each crew member for each of the three performance task groups. In addition, Level 2 scores are obtained for crew coordination in each of the three performance groups. If the scenario has two sessions, a separate set of Level 2 scores are computed from the Level 1 scores of the second session. Level 3 scores are computed for each crew member and crew coordination from the Level 2 performance measurement group scores. In computing Level 3 scores, each individual Level 2 score is first multiplied by a predetermined weight and then summed. The total score is then reduced by the appropriate

criticality factors. The Level 3 scores are combined in a like manner to obtain an overall Level 4 score for each of the two scenario sessions. The two Level 4 scores are combined for a single Level 5 score for the entire mission.

As part of the test of the validity of the PMS assessment procedures, an analysis will be conducted to see how Level 2 and higher scores relate to instructor evaluations of crew performance. In addition, experienced flight instructor crews will be compared with inexperienced flight student crews on these PMS measures to determine if the scores can discriminate between experienced and inexperienced personnel. Since the assignment of weight and criticality factors involves a certain amount of subjectivity, different weight and criticality factors will be used in scoring. These new scores will then be tested for relation with instructor evaluation and discrimination ability. This evaluation should help to determine how much care is needed in assigning weight and criticality factors to the various levels of scores.

Operational Utility. The PMS is designed as a teaching aid for C-5A instructors. There are four basic teaching aids performed by the PMS: performance feedback to the student, objective mission assessment, mission monitoring for the instructor, and mission tailoring to student needs. Performance feedback is provided for the student in the form of a printed debriefing report. The report indicates which tasks were incorrectly performed, which flight parameters were out of bounds, etc. The report also contains the five levels of scoring as an objective assessment of the mission. During a simulated mission, the PMS provides the instructor a display which alerts him as soon as a student error is committed. The display also provides the means to monitor the progress of the mission, the course heading, the values of various parameters, etc. In the manual mode, the instructor has the freedom to alter the mission by inserting or clearing various simulated aircraft malfunctions, change selected simulated atmospheric conditions, suspend the session, skip over portions of the scenario, repeat portions of the scenario, etc. These instructor options provide the instructor with the ability to individualize the session to the students.

In order to determine the perceived utility of the PMS in the C-5A training program, the reaction of the instructors and students to the system is needed. In this regard, some questions include: Are the PMS displays and printouts conveying the necessary information or is there information not provided that would be useful? Is any of the information currently presented not needed? What PMS features are used most by the instructors? What additional features, if any, would the instructors like to have available to them?

Operational Suitability. Operational suitability factors pertain to how well a device meets accepted equipment serviceability requirements within its intended operating and maintenance environment. The major question is: How reliable is the PMS hardware in the operational environment? In order to answer this, a maintenance log and an instructor discrepancy log will be kept on the PMS during the entire test and evaluation period.

Preliminary Findings

The accomplishment of the above objectives required that the PMS be used in the various C-5A training courses. Three selected missions, Copilot

Missions 4, 5, & 6, have been designated as PMS missions. PMS scenarios have been developed for these missions and are currently used as part of the C-5A training curriculum at Altus AFB. As a result of this implementation several informal observations have been made relative to the operational utility of the PMS as perceived by the C-5A instructors.

Instructor Pilot Perceptions. Some of the initial observations included: (a) Navigational profile displays - These are considered the most popular feature among the IPs. As a result of the enthusiastic IP response, a graphics printer has been added to the PMS to provide copies of the ground track and glideslope displays for use in debriefings and between sessions; (b) Restart capability - Many IPs like the capability of restarting a navigational profile (e.g., an ILS approach) and having PMS reposition the simulator; (c) Multi-function keyboard - This is a source of difficulty for many IPs. As IPs gain experience in using the PMS, this problem may disappear; (d) Debriefing report - The order in which items appear on the report was not the order in which the IP would use them. Moreover, certain terms on the printout are not defined; and (e) Parameters monitoring - Most IPs do not like the parameters monitoring capability of PMS. Although they feel that maintenance of flight parameters is important, the quality of the basic simulator is such that it is impossible to maintain these within prescribed tolerances. In other words, the problem lies with the quality of the simulation and not the PMS.

Instructor Flight Engineer Perceptions. Some of the initial observations included: (a) Checklist/procedures monitoring - Most IFEs report that they like this capability, although the .8 sec sampling rate of the PMS is sometimes too slow to catch momentary switch positions. Many IFEs report that they like having PMS back them up when a student claims to have performed a step in a checklist when the IFE hasn't seen it; and (b) Automated malfunction insertion - Most IFEs like having the PMS insert the malfunctions. Without the PMS, the IFE follows a written syllabus that indicates what and when malfunctions are to be entered. The IFE must manually insert the malfunction at the specified time by throwing a switch or turning a knob on the malfunction panel. A few malfunctions, such as fluctuation in oil pressure, require constant instructor input.

A note of caution should be exercised in that these findings represent some of the initial responses to the use of the PMS. These perceptions may change as instructors gain experience in the use of the system. Data collection for the evaluation will continue through Dec 84 so that all test objectives can be achieved. At this point, there seems little doubt that many of the capabilities of the PMS will be considered a useful adjunct to training. As such, the product of this development program will lead to a better specification of requirements for such capabilities in future simulator acquisitions.

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